

Cladistic analysis of the tribe Xanthorhoini in the Holarctic region
(Lepidoptera, Geometridae)

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The tribe Xanthorhoini, a tribe of the Larentiinae, is a group of small to middle geometrid moths comprising more than 16 genera over the World. Previous studies indicated that this group is more or less a natural taxon, but the monophyly of the tribe is not clearly defined and this resulted in the ambiguity of the phylogenetic relationships. Two diagnostic characters for the tribe were recognized: a large pair of coremata just distal to the 8th segment in the male abdomen, and the presence of a 'calcar' in male genitalia.

The purpose of the present study is to define the monophyly of the tribe and certain subgroups and to reveal the phylogenetic relationships among genera in the Holarctic region. Fifty-nine morphological characters from head, body, wing and male and female genitalia were analysed. Thirty-eight ingroup taxa were selected – 28 species from the Palearctic, 6 species from the Nearctic and 4 species common in both Palearctic and Nearctic regions. A parsimony software package 'Winclada' (ver. 1.00.08; K. Nixon, 1999) was implemented for finding

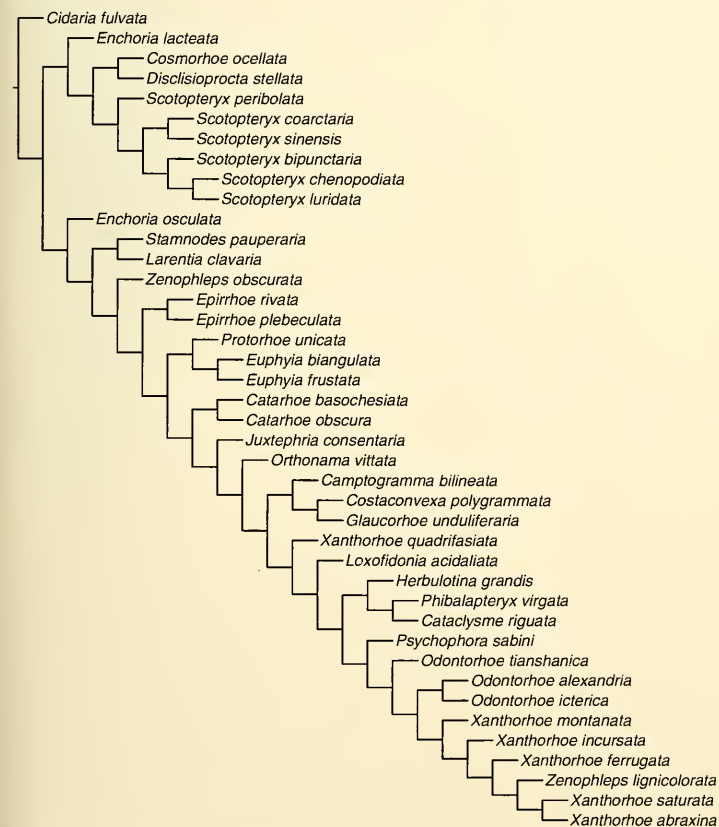


Fig. 1. Most parsimonious cladogram of 38 putative Xanthorhoini species and 3 outgroup taxa (see text).

the most parsimonious cladogram. Three outgroup taxa, *Cidaria fulvata*, *Stannodes pauperaria*, and *Larentia clavaria* were chosen for rooting the cladograms.

One most parsimonious cladogram was found ($L=452$, $ci=0.21$, $ri=0.47$). However, the resulting cladogram (Fig. 1) is divided into two clades and does not support the monophyly of the Xanthorhoini. In the cladogram, *Scotopteryx*, *Epirrhoe*, and *Euphyia* were monophyletic, while *Enchoria*, *Zenophleps*, *Odontorhoe*, and *Xanthorhoe* were not monophyletic. Overlapping the character 'presence and length of coremata' with the most parsimonious

cladogram showed that two states, long and short coremata, occurred independently in different clades and the state, long coremata, occurred three times independently in the cladogram. The overlap of the character 'presence of calcar' with the cladogram showed that the transition from the large, expanded shape of calcar to the digitate and relatively short calcar occurred three times independently. The future study including taxon sampling from the Nearctic region and character analysis from immature stages will reveal the monophyly of the Xanthorhoini and provide refined information on relationships among ingroup taxa.

Cladistic analysis of the subfamily Larentiinae

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Altogether about 230 species from 125 mostly Holarctic larentiine genera were studied preliminarily, checking the relations between traditionally recognized tribes. Synapomorphies of main generic clades are coded in the final matrix. Forty-six ingroup taxa and *Idaea aversata* (Linnaeus, 1758) as an outgroup species were included, 129 characters coded as unordered by convenience. The parsimony analysis using the application of Hennig86 yielded one weighted tree of 795 steps length, with consistency index, $ci=0.72$ and rescaled consistency index, $ri=0.89$. 17 suprageneric groups are supported by synapomorphic characters.

Synthesis. The monophyly of generic groups is analyzed using cladistic methodology, the sequence of resulting clades is defined by other means.

Larval chaetotaxy is studied fragmentarily. However, the Eudulini, Operophterini, Asthenini, Rheumapterini a.s.o. to the Eupitheciini, Chesiadini and Trichopterygini (cf. Table 1) bear four secondary setae laterally on the prolegs. The Lythriini, Xanthorhoini, Stannodini, Larentiini and Hydriomenini have eight or more, the Euphyiini and Cidariini five or six secondary setae (according to literature, and original data). It is merely to decide which state of this character is primitive, and which is derived.

Males in three tribes, the Xanthorhoini, Cataclymini and Euphyiini, have large coremata associated with membranization of last but one and last abdominal segments. In the Eupitheciini, the core-

mata are attached to the ninth segment and the male eighth sternite is specialized to open the female colliculum during the early phase of copulation (Mikkola 1994). The structures are not homologous, as well as the presence of two pairs of coremata on the male eighth abdominal segment in some Rheumapterini, and their sporadic occurrence in scattered cidariine and asthenine genera, judged by the differences in sclerotization of last abdominal segments.

The labides are present in several clades. The valvae often are ornamented and projecting distally at dorsal or ventral margin, or on both; only in the Chesiadini, the presence of a harpe is more or less constant.

A peculiar, *Eupithecia*-type of ornamentation of female bursa copulatrix with numerous spines having star-shaped or petaloid bases, is observed within Geometridae only in some tribes of Larentiinae and in some species-groups of the sterrhine genus *Idaea*. If the groups with the *Eupithecia*-type of bursa ornamentation are relatively derived, the groups with four secondary setae laterally on the larval prolegs are to be grouped with Eupitheciini, and the larger number of setae on the prolegs results to be less derived. An early analysis of Kuznetsov (1969), based on food-plant associations of tortricids, has shown the leading evolutionary trend from detritophagy to leaf-eating and further to antho- and carpophagy. The Perizomini are anthophagous, the Eupitheciini are antho- and carpophagous.